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(54) **MIXING APPARATUS FOR CRUSHING SLUDGE**

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(30) **Foreign Application Priority Data**

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C02F 11/14	(2006.01)

(52) **U.S. Cl.**

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(58) **Field of Classification Search**

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See application file for complete search history.

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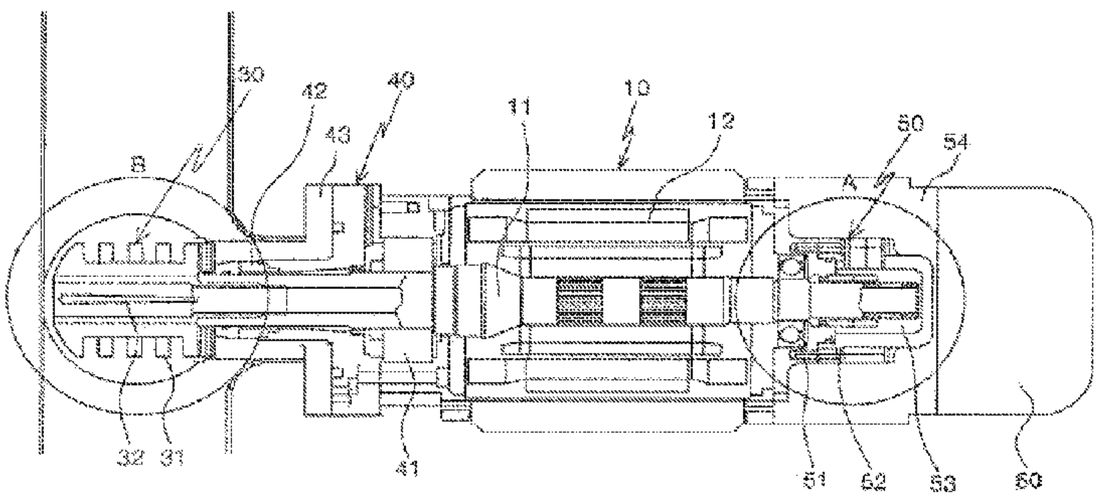
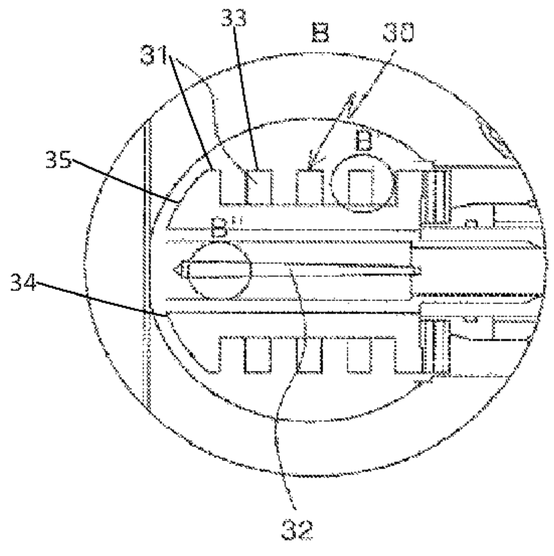
(57) **ABSTRACT**

The present invention relates to mixing apparatus for crushing sludge comprising a motor part in which a rotary shaft is inserted into the motor part and the motor part is rotated, a moving part formed to penetrate the motor part from one side to another side and move a chemical which is flowed through an outside chemical feeder to the another side, and a paddle mounted on the another side of the motor part to rotate based on the rotation of the motor part and spray the chemical.

20 Claims, 3 Drawing Sheets





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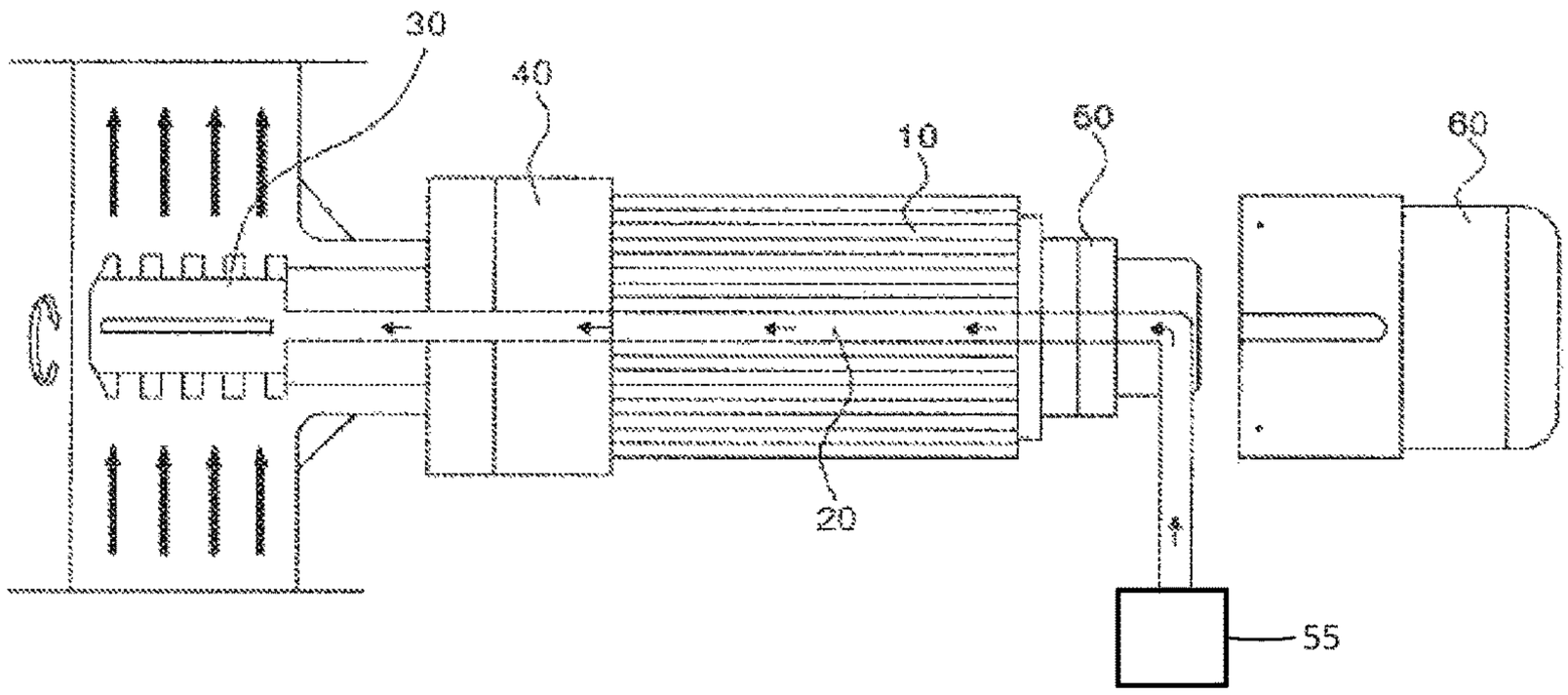

FIG 1

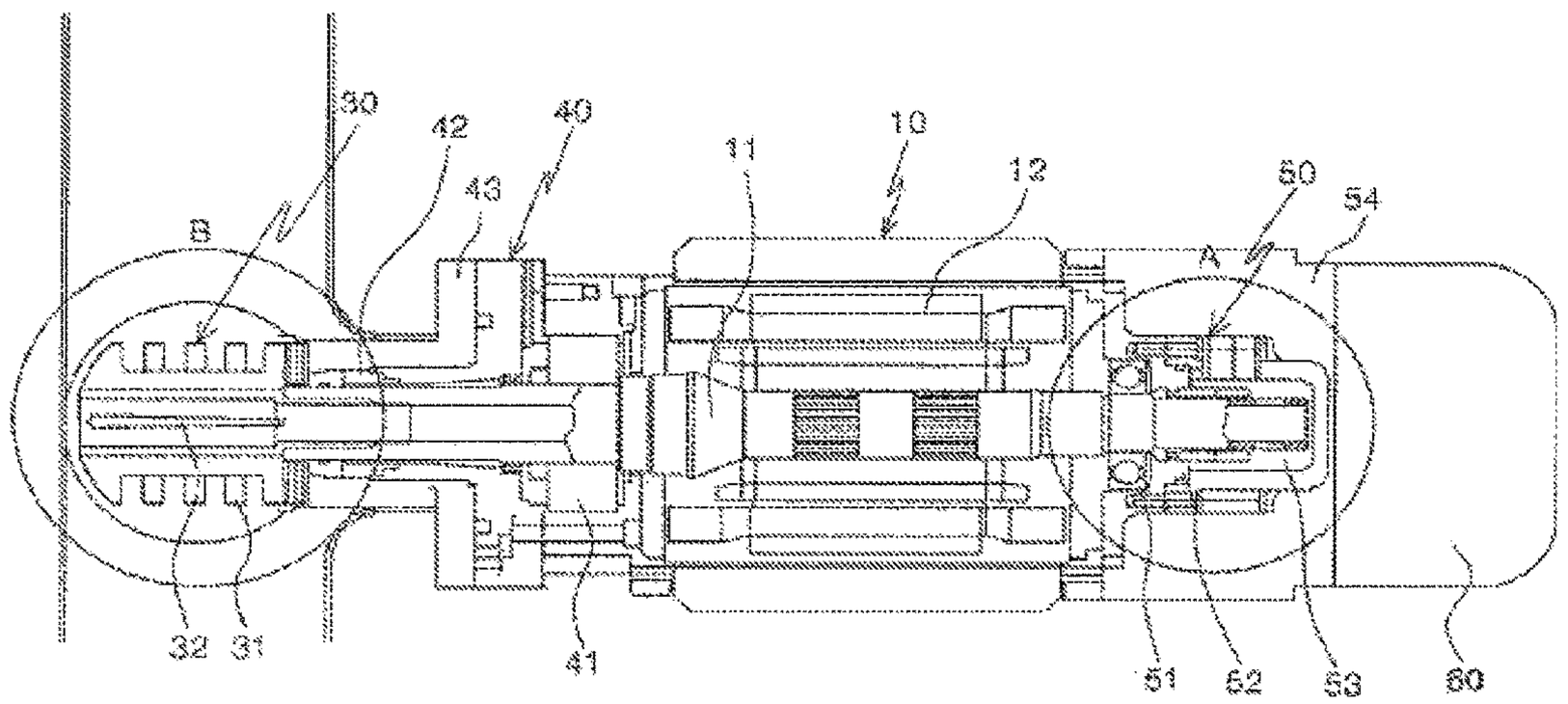

FIG 2

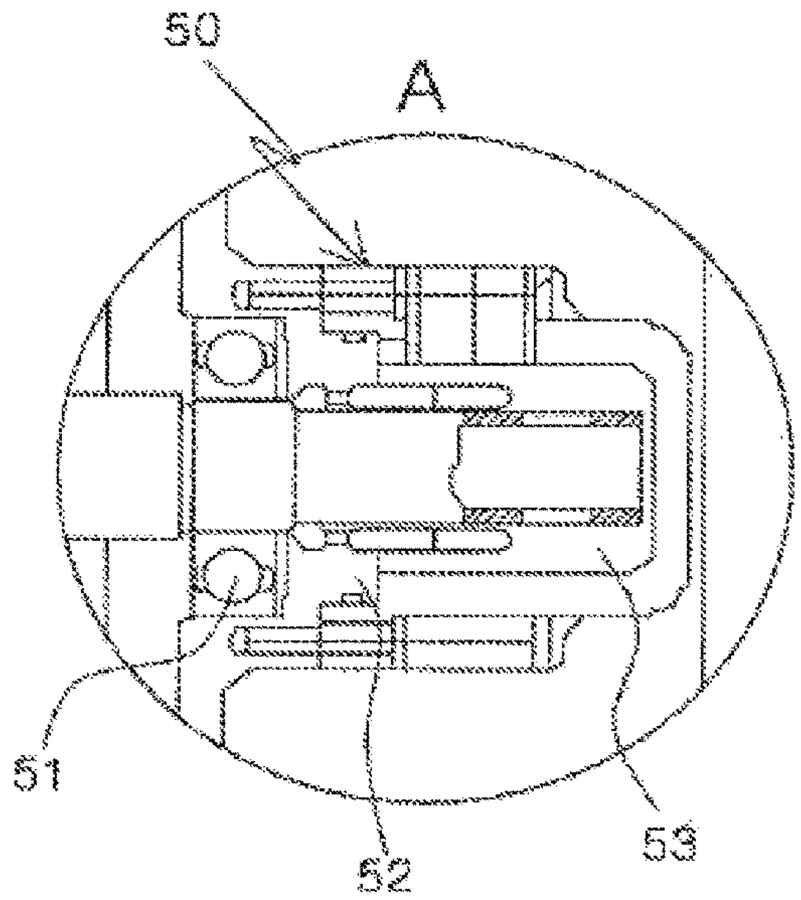

FIG 3

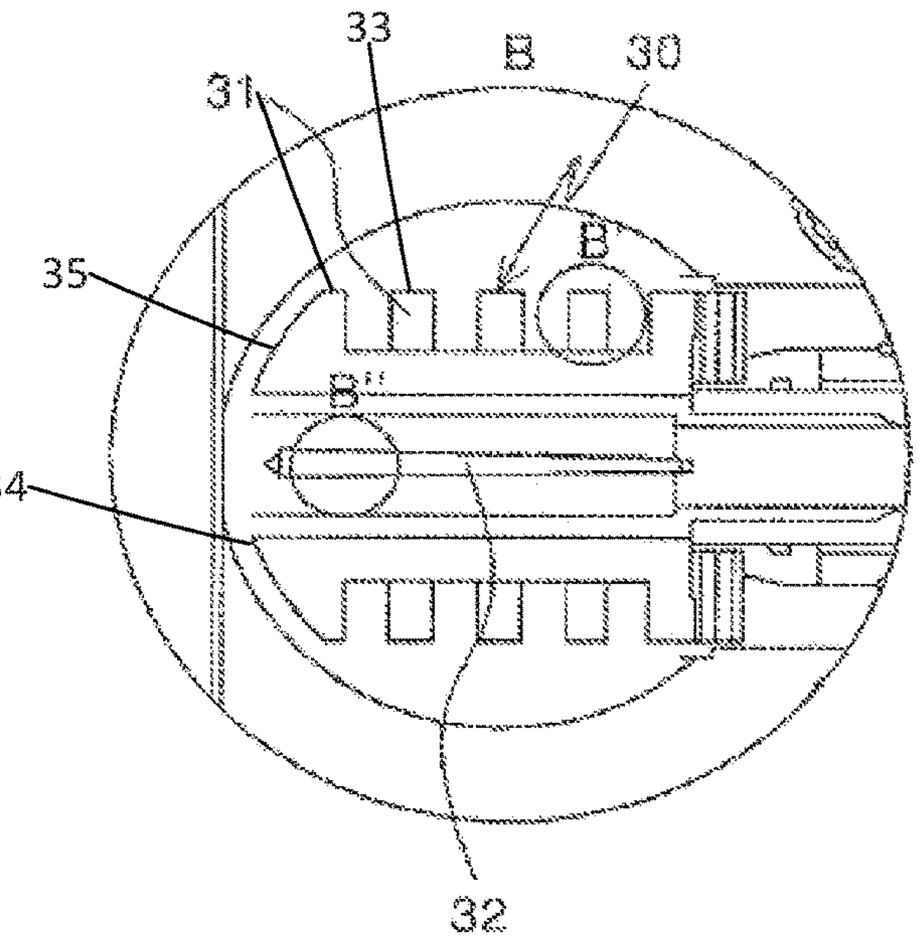

FIG 4

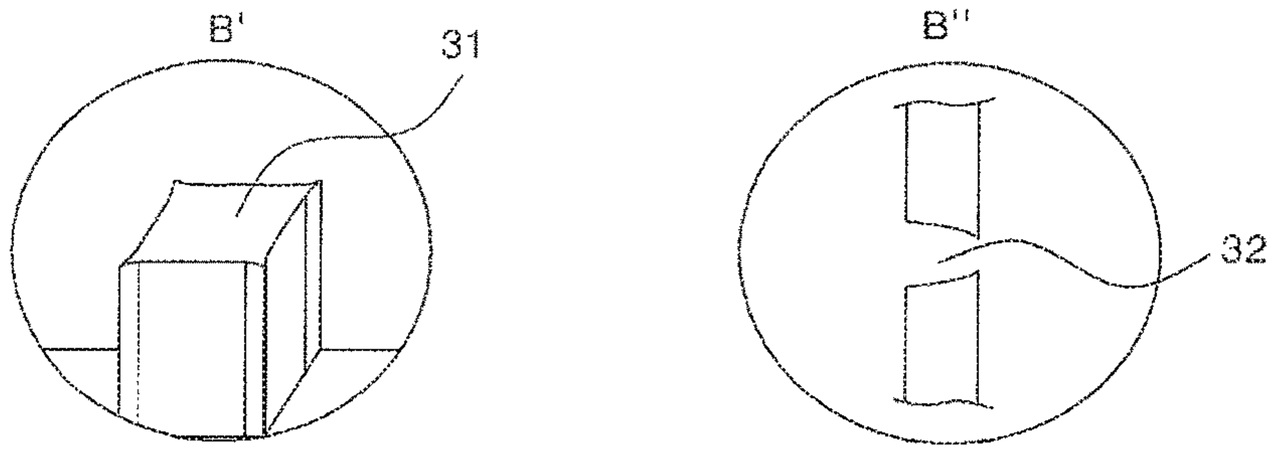

FIG 5

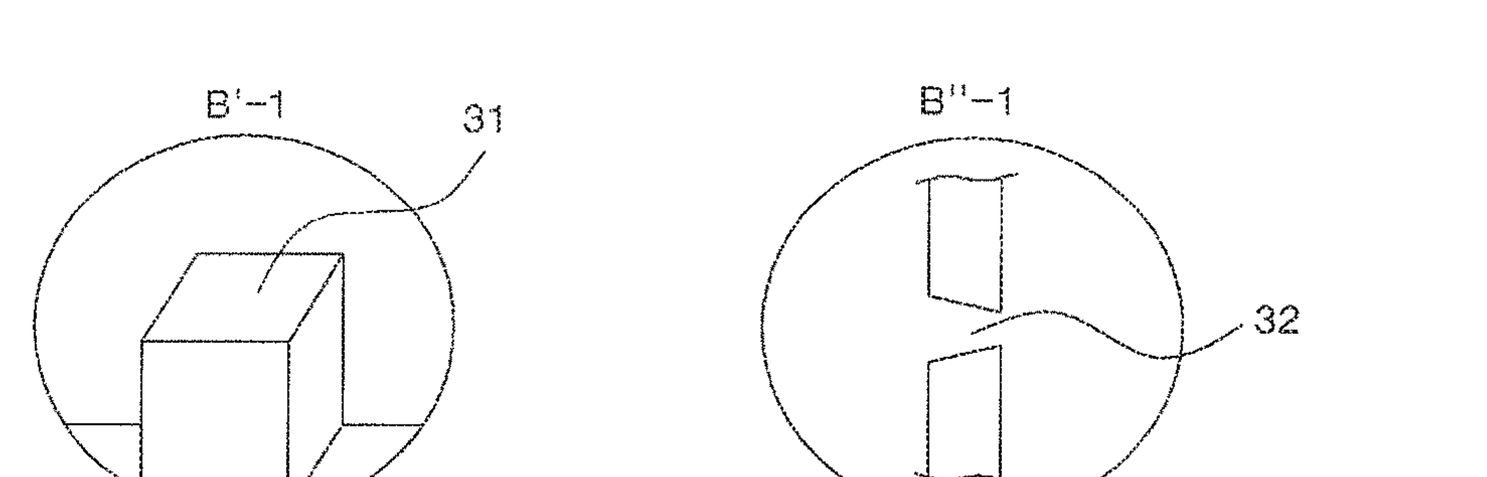

FIG 6

MIXING APPARATUS FOR CRUSHING SLUDGE

RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 13/961,361, filed Aug. 7, 2013, and entitled "MIXING APPARATUS FOR CRUSHING SLUDGE" which claims the benefit of PCT Application No. PCT/EP2012/055881, filed Mar. 30, 2012, and entitled "MIXING APPARATUS FOR CRUSHING SLUDGE" which claims the benefit of foreign application KR 10-2011-0028873 filed Mar. 30, 2011. The entire contents of these application is incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to a mixing apparatus for crushing sludge.

BACKGROUND

In general, in order to remove floating matters contained in waste water and water through coagulation and sedimentation, a chemical (coagulant) is fed into the waste water and the like to cause a coagulation reaction.

Through the coagulation reaction, a flock is formed coagulated by a coagulant such as a particle of an organic matter and a microbe or a suspended material of the waste water and the like. For the flock formation in the precipitation tank, the thickener tank, and the like, the chemical (coagulant) is fed into a pipe or the chemical (coagulant) is fed separately into the precipitation tank, the thickener tank, and the like in general

In the case of the abovementioned typical method, raw water (sludge) and the chemical (coagulant) are not agitated appropriately, and the flock is formed insufficiently, which leads to an overfeeding of the chemical during the flock formation.

In the case of a belt press dehydrator for a sludge dehydration process, an agitator of a quadrangular agitation tank at a front rotates at a slow speed to carry out agitation. In this case, sufficient time is not provided for the raw water (sludge) and the chemical (coagulant) to react with each other, and sizes of the formed flocks are irregular and large, hindering an even distribution at the belt press dehydrator.

Also, adequate agitation is unlikely while the flock stays in the agitator, which leads to the overfeeding of the chemical during the dehydration process. Therefore, a filter cloth is clogged, water filtering performance is lowered, and an increase in water content becomes unavoidable.

A centrifugal dehydrator feeds the chemical by connecting a raw water (sludge) pipe leading to the belt press dehydrator with a chemical (coagulant) pipe. A simultaneous feeding into the belt press dehydrator is made, and the flock formation and dehydration is conducted by a turning force of the centrifugal dehydrator. Since the coagulation reaction is carried out in the belt press dehydrator, the reaction is made inadequately before discharge, meaning that the water content is maintained higher than a design value during operation, and operation efficiency of the dehydrator drops due to the flock formation based on the overfeeding of the chemical

Technical Solution for the Problem

The problem to be solved by the present invention is to provide a new mixing apparatus for crushing sludge, preferably installed at a raw water (sludge) pipe to mix raw water (sludge) with a chemical (coagulant) in a precipitation tank, a thickener tank, a thickener, and a dehydration process at a filtration plant, a waste water disposal plant, etc.

Technical Solution for the Problem

This problem is solved by a mixing apparatus according to claim **1**. Advantageous and/or preferred embodiments can be obtained from the dependent claims.

In particular, a mixing apparatus for crushing sludge according to the invention may include a motor part in which a rotary shaft is inserted into the motor part and the motor part is rotated, a moving part formed to penetrate the motor part from one side to another side and move a chemical which is flowed through an outside chemical feeder to the another side, and a paddle mounted on the another side of the motor part to rotate based on the rotation of the motor part and spray the chemical.

The paddle may have a moving hole which the chemical moves inside, a discharge hole connected to the moving hole and discharging the chemical outside, and a saw-toothed part projecting outside.

An inner wall surface of the discharge hole and a corner of the saw-toothed part of the paddle may be formed sharply.

The motor part may include a main body in which the rotary shaft is inserted into the main body, a first plate combined with one side of the main body and one outer circumference of the shaft, and a second plate combined with another side of the main body and another outer circumference of the shaft.

The shaft may have a penetrating path inside to move the chemical fed at one side to another side.

The first plate may include a first bearing part combined with an outer circumference of the shaft, a first sealing part combined to surround the first bearing part, and an inlet part formed in the first sealing part and allowing the chemical fed from outside to flow to a penetrating path of the shaft.

The first sealing part may be a mechanical seal.

The second plate may include a second bearing part combined with an outer circumference of the shaft, a second sealing part combined to surround the second bearing part around an outer circumference of the second bearing part, and a securing part surrounding the second bearing part and the second sealing part, and securing the second bearing part and the second sealing part to the another side of the motor part.

The second sealing part may be a mechanical seal.

The moving part may include an inlet part formed on the first plate and allowing the chemical to flow in, a penetrating path formed in the shaft of the motor part, and a moving hole formed in the paddle.

The mixing apparatus may be installed, in particular vertically, at a raw water (sludge) pipe to mix raw water (sludge) with a chemical (coagulant) in a precipitation tank, a thickener tank, a thickener, and a dehydration process at a filtration plant, a waste water disposal plant, etc.

Effect of the Invention

According to the present invention, dehydrator efficiency is raised and water content of a dehydration cake is lowered since a microbial cell is destroyed by a corner of a saw-toothed part of a rotating paddle while cavitation is induced to remove moisture contained in the microbial cell.

Further, since agitation is conducted by the paddle rotating at a high speed in a narrow pipe, an even and solid flock

is made by using a proper amount of chemical (coagulant) so that the chemical (coagulant) is saved compared to a previous chemical (coagulant) feeding method. Sludge sedimentation and thickening efficiency improves, and overall efficiency of water purification and waste water treatment increases.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a general view of a mixing apparatus for crushing sludge according to the present invention.

FIG. **2** is a sectional view of the mixing apparatus for crushing sludge according to the present invention.

FIG. **3** is an enlarged view showing portion A of FIG. **2**.

FIG. **4** is an enlarged view showing portion B of FIG. **2**.

FIG. **5** is enlarged views showing portions B' and B" of FIG. **4**.

FIG. **6** is an exploded view of the mixing apparatus for crushing sludge according to the present invention.

DETAILED DESCRIPTION FOR CARRYING OUT THE INVENTION

Hereinafter, the present invention will be described in detail by explaining preferred embodiments of the invention with reference to the attached drawings. Like reference numerals in the drawings denote like elements. Moreover, detailed descriptions related to well-known functions or configurations will be ruled out in order not to unnecessarily obscure subject matters of the present invention.

With reference to FIGS. **1** and **2**, a mixing apparatus for crushing sludge of the present invention includes a motor part **10**, a moving part moving a chemical, a paddle **30** disposed at another side of the motor part **10** to spray the chemical while rotating, a cooling fan **60** disposed at a side of the motor part **10** to cool the motor part **10**.

The motor part **10** includes a shaft **11** inserted into an inside of a main body **11**, and first and second plates **40** and **50** coupled with both ends of the shaft **11**. The cooling fan **60** is disposed at the side of the motor part **10** to cool the motor part **10**.

The moving part includes an inlet part **53**, disposed at a first sealing part **52** of the first plate **50** so that the chemical (coagulant) flows in through the inlet part **53**, a penetrating path disposed at the shaft **11** of the motor part **10**, and a moving hole formed in the paddle **30**.

The moving part may form the inlet part **53** at the second plate **40**.

The shaft **11** rotates in the main body **11**. The penetrating path is formed inside in a length direction, and an inlet hole connected to the penetrating path is formed at one side end outer circumference.

The first plate **50** is coupled with a side of the shaft **11**, and the second plate **40** is coupled with another side.

With reference to FIG. **3**, the first plate **50** includes a first bearing part **51** coupled with one outer circumference of the shaft, the first sealing part **52** surrounding and coupled with the first bearing part **51**, and the inlet part **53** disposed in the first sealing part **52**.

The first bearing part **51** is disposed between the shaft **11** and the first sealing part **52** so that the shaft **11** rotates smoothly.

The first sealing part **52** conducts sealing so that the chemical, which may leak out of the inlet part **53** disposed inside, does not leak out.

The first sealing part **52** may be a mechanical seal.

Here, the first sealing part **52** may be the mechanical seal because there is an automatic control function not to affect sealing performance even when a sealing material is worn out to a certain extent through friction.

In addition, a leap seal, a grand packing, and a leakage seal may be used for the first sealing part **52**.

The inlet part **53** disposed in the first sealing part **52** feeds the chemical supplied from an external chemical feeder **55** into the penetrating path through the inlet hole of the shaft **11**.

A cover part **54** is disposed at an exterior of the first sealing part **52** to protect the first sealing part **52**.

The second plate **40** includes a second bearing part **41** coupled with the other outer circumference of the shaft **11**, a second sealing part **42** surrounding and coupled with the second bearing part **41**, and a securing part surrounding and fixing the second bearing part **41**.

The second bearing part **41** is disposed between the shaft **11** and the second sealing part **42** so that the shaft **11** rotates smoothly.

The second sealing part **42** is coupled with another side of the shaft **11**, surrounds and is coupled with the second bearing part **41**, and conducts sealing so that the chemical does not leak out of the another side of the shaft **11**.

The second sealing part **42** may be the mechanical seal.

Here, the second sealing part **42** may be the mechanical seal because there is the automatic control function, as is the case of the first sealing part **52**, not to affect the sealing performance even when the sealing material is worn out to the certain extent through the friction.

In addition, the leap seal, the grand packing, and the leakage seal may be used for the second sealing part **42**.

The securing part is coupled with an outer side of the second sealing part **42** to fix the second sealing part **42** at another side of the main body **11**.

The paddle **30** is coupled with another side of the second plate **40**.

With reference to FIG. **4**, the paddle **30** is connected to another side of the shaft **11**. A moving path is disposed in the paddle **30**, and the moving path is connected to the penetrating path of the shaft **11** so that the chemical is fed into the paddle **30**.

A discharge hole **32** is formed at an outer circumference of the paddle **30** so that the chemical moving through the moving path is discharged.

A plurality of saw-toothed parts, or projections, **31** is terminate in an outward edge **33** and are disposed at the outer circumference of the paddle **30** in the length and outside direction to crush the sludge while the paddle **30** is rotating and form a flock by mixing the chemical with the sludge. Paddle **30** is also shown to include distal portion **34** and curved end **35**.

The discharge hole **32** and the saw-toothed part **31** have a sharply formed corner because the corner of the discharge hole **32** and the saw-toothed part **31** may crush a microbe in the sludge and increase flock formation while the paddle **30** rotates and increases cavitation. By crushing the microbe hindering coagulation, coagulation efficiency improves and moisture contained in a cell of the microbe is discharged.

Here, the cavitation is defined as creation of a space devoid of water, occurring when a low-pressure zone is formed in a fluid and a gas contained in the water escapes the water to be collected at the low-pressure zone.

According to the present invention, a hollow space is temporarily created in a fluid around the paddle due to

high-speed rotation of the paddle, and a vacuum zone or a low-pressure zone is created temporarily. The zone is called cavity part.

With reference to FIG. **5**, the corner of the discharge hole **32** and the saw-toothed part **31** may be blade-shaped or perpendicular.

The paddle **30** rotates at a velocity between 2,500 revolutions per minute (RPM) and 4,500 RPM.

Here, the paddle **30** may rotate at the velocity between 3,000 RPM and 4,000 RPM.

The present invention is explained in greater detail below.

The motor part **10** includes the main body **11** in which the shaft **11** is coupled and rotates, the first plate **50** coupled with the side of the shaft **11**, and the second plate **40** coupled with the another side of the shaft **11**.

The paddle is coupled with another side of the second plate **40**.

The paddle **30** is connected to the shaft **11**, rotates with the shaft **11** when the shaft **11** rotates, and crushes the sludge and forms the flock through the rotation.

When the chemical supplied from the external chemical feeder is fed into the inlet part **53** disposed in the first sealing part **52**, the chemical is moved to the another side through the penetrating path disposed in the length direction of the shaft **11**. Here, the first bearing part **51** is disposed between the first sealing part **52** and the shaft **11** so that the shaft **11** rotates smoothly.

The chemical moved through the penetrating path of the shaft **11** is discharged out of the discharge hole **32** through the moving hole of the paddle **30** connected to the another side of the shaft **11**.

The second sealing part **42** is disposed at a joint between the shaft **11** and the paddle **30** so that the chemical is does not leak out. The second bearing part **41** is disposed between the securing part surrounding and fixing the outer side of the second sealing part **42** and the shaft **11** so that the shaft **11** rotates smoothly.

The chemical discharged out of the discharge hole **32** is mixed with the sludge and the flock is formed while the paddle **30** rotates.

The saw-toothed parts **31** are disposed in the outside direction at the outer circumference of the paddle **30** so that the flock is formed smoothly. The saw-toothed parts **31** crush a microbial cell in the sludge colliding during the rotation so that the moisture contained in the microbial cell is discharged.

Here, the cavitation occurs around the paddle **30** due to the rotation of the paddle **30**, and the moisture contained in the crushed microbial cell is squeezed.

According to the present invention, dehydrator efficiency is raised and water content of a dehydration cake is lowered since the microbial cell is destroyed by the corner of the saw-toothed part of the rotating paddle while the cavitation is induced to remove the moisture contained in the microbial cell.

Further, since agitation is conducted by the paddle rotating at a high speed in a narrow pipe, an even and solid flock is made by using a proper amount of the chemical (coagulant) so that the chemical (coagulant) is saved compared to a previous chemical (coagulant) feeding method. Sludge sedimentation and thickening efficiency improves, and overall efficiency of water purification and waste water treatment increases.

While this invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims. The scope of the invention is defined not by the detailed description of the invention but by the appended claims, and all differences within the scope will be construed as being included in the present invention.

DESCRIPTION OF THE SYMBOLS

10 Motor Part
11 Shaft
12 Main Body
20 Moving Part
30 Paddle
31 Saw-toothed Part
32 Discharge Hole
40 Second Plate
41 Second Bearing Part
42 Second Sealing Part
43 Securing Part
50 First Plate
51 First Bearing Part
52 First Sealing Part
53 Inlet Part
54 Cover Part
60 Cooling Fan

We claim:

1. A system for mixing comprising:

a sludge pipe configured to transport a sludge therethrough;

an external chemical feeder configured to supply a chemical into the sludge pipe; and

a mixing apparatus secured to the sludge pipe and configured to mix the chemical with the sludge, the mixing apparatus comprising:

a motor configured to rotatably drive a shaft coupled to the motor at a first end of the shaft, the shaft defining a central rotational axis, and

a paddle connected to a second end of the shaft and configured to rotate with the shaft, the paddle extending into the sludge pipe and terminating in a curved end, the paddle having at least one projection extending in an outward direction from the central rotational axis of the shaft and terminating in an outward edge, the outward edge being parallel with the central rotational axis of the shaft.

2. The system of claim **1**, wherein the at least one projection is integral with the curved end.

3. The system of claim **1**, wherein the paddle extends into the sludge pipe in a direction parallel to the central rotational axis, and wherein the curved end curves toward the outward edge as the curved end extends in a direction away from the central rotational axis.

4. The system of claim **1**, wherein the curved end curves in the outward direction from the central rotational axis as the paddle extends proximally from a distal portion of the paddle, the distal portion of the paddle being the portion of the paddle extending furthcri furthest into the sludge pipe.

5. The system of claim **1**, wherein the at least one projection extending in the outward direction from the central rotational axis of the shaft and terminating in the outward edge comprises a first projection extending in the outward direction from the central rotational axis of the shaft and terminating in a first outward edge and a second projection extending in the outward direction from the central rotational axis of the shaft and terminating in a second outward edge, each of the first outward edge and the second outward edge being parallel with the central rota-

tional axis of the shaft, wherein each of the first projection and the second projection is integral with the curved end.

6. The system of claim **1**, wherein the mixing apparatus further comprises a plate that secures a main body of the motor to the sludge pipe, and wherein the shaft extends within the plate.

7. The system of claim **6**, wherein the plate includes a sealing part configured to provide a seal between the main body of the motor and the sludge pipe.

8. The system of claim **7**, wherein the plate includes a bearing part disposed between the sealing part and the shaft.

9. The system of claim **8**, wherein the plate includes a securing part coupled to an outer side of the sealing part.

10. The system of claim **6**, wherein the external chemical feeder is spaced from the main body of the motor.

11. The system of claim **1**, wherein the external chemical feeder is configured to supply the chemical into the sludge pipe at locations spaced apart and aligned along a diameter of the sludge pipe.

12. The system of claim **1**, wherein the at least one projection includes a first side edge and a second side edge each extending in the outward direction, and wherein the outward edge is parallel with the central rotational axis of the shaft along a distance that extends from the first side edge to the second side edge.

13. A method for water treatment, the method comprising the steps of:

discharging a chemical into a sludge pipe, wherein the chemical is discharged into the sludge pipe at locations spaced along a diameter of the sludge pipe;

rotatably driving a shaft having a first portion that is coupled to a motor, the shaft defining a central rotational axis; and

forming a flock when the shaft is rotatably drive by the motor by intermixing the chemical with a sludge in the sludge pipe using a paddle that is coupled to a second portion of the shaft and extends into the sludge pipe, wherein the paddle terminates in a curved end at a distal portion of the paddle that extends furthest into the sludge pipe, wherein the paddle has a first projection extending in an outward direction from the central rotational axis of the shaft and terminating in a first outward edge, the first outward edge being parallel with the central rotational axis of the shaft.

14. The method of claim **13**, wherein the paddle has a second projection extending in the outward direction from the central rotational axis of the shaft and terminating in a second outward edge, the second outward edge being parallel with the central rotational axis of the shaft, and wherein the shaft is rotatably driven when forming the flock such that the first projection contacts a portion of the chemical and sludge at a first time and the second projection contacts the portion of the chemical and sludge at a second later time.

15. The method of claim **14**, wherein the first projection and the second projection are spaced about the shaft and integral with the curved end.

16. The method of claim **13**, further comprising the step of:

removing moisture from a microbial cell in the sludge when rotatably driving the shaft by contacting the microbial cell with the curved end.

17. The method of claim **13**, wherein the chemical is discharged into the sludge pipe from an external chemical feeder.

18. The method of claim **13**, wherein the locations spaced along the diameter of the sludge pipe from which the chemical is discharged into the sludge pipe are aligned at a common longitudinal location of the sludge pipe.

19. The method of claim **13**, wherein rotatably driving the shaft includes contacting an outer circumference of the first portion of the shaft with a bearing part disposed between the outer circumference of the shaft and a sealing part that seals between a main body of the motor and the sludge pipe.

20. A system for mixing comprising:

a sludge pipe configured to transport a sludge therethrough in a first direction of flow;

an external chemical feeder configured to supply a chemical into the sludge pipe at locations that are spaced from one another along an axis that is perpendicular to the first direction of flow; and

a mixing apparatus secured to the sludge pipe at a plate and configured to mix the chemical with the sludge, the mixing apparatus comprising:

a motor having a main body and configured to rotatably drive a shaft coupled to the motor at a first portion of the shaft, the shaft extending within the plate and defining a central rotational axis,

a sealing part located between the main body of the motor and the sludge pipe and configured to provide a seal therebetween,

a bearing part located between the first portion of the shaft and the sealing part, and

a paddle connected to a second portion of the shaft and configured to rotate with the shaft,

wherein the paddle extends into the sludge pipe and terminates in a curved end, the paddle having at least one projection extending in an outward direction from the central rotational axis of the shaft and terminating in an outward edge, the outward edge being parallel with the central rotational axis of the shaft.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 10,227,249 B2
APPLICATION NO. : 15/373805
DATED : March 12, 2019
INVENTOR(S) : Seung-Nyung Huh et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

Claim 4, Column 6, Line 57, after “extending” delete “furthcri”.

Signed and Sealed this
Sixth Day of August, 2019

Andrei Iancu
Director of the United States Patent and Trademark Office